



UNITED STATES  
NUCLEAR REGULATORY COMMISSION

REGION II  
SAM NUNN ATLANTA FEDERAL CENTER  
61 FORSYTH STREET, SW, SUITE 23T85  
ATLANTA, GEORGIA 30303-8931

June 29, 2006

Duke Energy Corporation  
ATTN: Mr. D. M. Jamil  
Site Vice President  
Catawba Site  
4800 Concord Road  
York, SC 29745-9635

SUBJECT: CATAWBA NUCLEAR STATION - NRC AUGMENTED INSPECTION TEAM  
(AIT) REPORT 05000413/2006009 AND 05000414/2006009

Dear Mr. Jamil:

On May 26, 2006, the U. S. Nuclear Regulatory Commission (NRC) completed an Augmented Inspection at your Catawba Nuclear Station, Units 1 and 2. The enclosed report documents the inspection findings, which were preliminarily discussed on May 26 with you and other members of your staff. A public exit was conducted with you and members of your staff on May 31, 2006.

The events that led to the conduct of the Augmented Inspection can be summarized as follows:

On May 20, 2006, at approximately 2:01 p.m. EDT, a phase-to-ground electrical fault on a current transformer in the 230kV switchyard associated with the Catawba Unit 1 main step-up transformer 1A initiated a sequence of events that resulted in a Loss of Offsite Power (LOOP) event for both Unit 1 and Unit 2. A tap setting on bus differential relaying for the "Red" and "Yellow" busses within the "breaker-and-a-half" switchyard configuration scheme, which had been set incorrectly since prior to the initial commercial operation of the plant, was a major contributory element to this event.

On May 22, 2006, a second event, unrelated to the first, occurred as preparations were being made to restore the secondary-side plant on Unit 2 and return secondary-side heat removal to the steam dumps from the steam generator power operated relief valves. Water overflowing from the Unit 2 cooling towers traveled through unsealed electrical conduits in cable trenches and manholes and entered the 1A diesel generator room, resulting in the 1A diesel generator being declared inoperable.

Based on the risk and deterministic criteria specified in Management Directive 8.3, "NRC Incident Investigation Program," and the significance of these operational events, an NRC Augmented Inspection Team (AIT) was dispatched to the site on May 23, 2006 in accordance with Inspection Procedure 93800, "Augmented Inspection Team." The purpose of the inspection was to evaluate the facts and circumstances surrounding the events, as well as the actions taken by your staff in response to the events. The inspection focus areas are detailed in the Augmented Inspection Team Charter (Attachment 5). The team reviewed your immediate and planned corrective actions prior to restart, including your actions to improve the independence and reliability of offsite power sources, and found those actions appropriate for

continued operation of the units. The team found some issues which will require additional inspection followup. These issues are identified as unresolved items in the report.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room).

Sincerely,

**/RA/**

Charles A. Casto, Director  
Division of Reactor Projects

Docket Nos.: 50-413, 50-414  
License Nos.: NPF-35, NPF-52

Enclosure: NRC Inspection Report 05000413/2006009 and 05000414/2006009  
w/Attachments: Supplemental Information

cc w/encl: (See page 3)

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cc w/encl:

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DEC

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**U.S. NUCLEAR REGULATORY COMMISSION**

**REGION II**

Docket Nos.: 50-413, 50-414

License Nos.: NPF-35, NPF-52

Report Nos.: 05000413/2006009 and 05000414/2006009

Licensee: Duke Energy Corporation

Facility: Catawba Nuclear Station, Units 1 & 2

Location: 4800 Concord Road  
York, SC 29745

Dates: May 23 - 31, 2006

Team Leader: James H. Moorman, III, Chief  
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Division of Reactor Safety

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W. Lewis, Reactor Inspector

Approved by: Charles A. Casto, Director  
Division of Reactor Projects

Enclosure

## SUMMARY OF FINDINGS

IR 05000413/2006009, 05000414/2006009; 5/23-31/06; Catawba Nuclear Station, Units 1 and 2; Augmented Inspection.

This inspection was conducted by a team consisting of inspectors from the NRC's Region II office and resident inspectors from the Catawba and V.C. Summer Nuclear Stations. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000. An Augmented Inspection Team was established in accordance with NRC Management Directive 8.3, "NRC Incident Investigation Program" and implemented using Inspection Procedure 93800, "Augmented Inspection Team."

A. NRC-Identified and Self-Revealing Findings

To be determined through the Reactor Oversight Program review of this report.

B. Licensee Identified Findings

None.

An NRC Augmented Inspection Team was dispatched to the site on May 23 to review the loss of offsite power (LOOP) event and the partial flooding of the 1A diesel generator (DG) room. The team found that the licensee's response to the LOOP event and to the partial flooding of the 1A DG room was generally acceptable. The team identified four issues for inspection followup. These issues are tracked as unresolved items in this report.

## **REPORT DETAILS**

### **Summary of Plant Events**

On May 20, 2006, at 2:01 p.m., an electrical fault in the Catawba 230kV switchyard caused several power circuit breakers (PCB's) to open resulting in a loss of all offsite power (LOOP) and a subsequent reactor trip of both units from 100 percent power. All reactor trip breakers opened as expected and all control rods fully inserted into the core on the two units. Both main turbines tripped upon receipt of the P4 protective signals following the reactor trips. Control room operators responded to the event using normal, abnormal and emergency operating procedures.

Following the LOOP, the four (4) emergency diesel generators started and supplied power to the 4.16kV vital busses. Designated vital equipment was re-energized in accordance with the plant design through the diesel generator load sequencers.

A Notice of Unusual Event (NOUE) was declared at 2:14 p.m. on May 20, 2006, due to the loss of AC electrical power from all offsite sources for more than 15 minutes with onsite power available. The Technical Support Center (TSC), Operations Support Center (OSC), and subsequently the Emergency Operations Facility (EOF) were all activated on a precautionary basis to provide support as required.

Power was restored to the Unit 2 6.9kV busses at 8:27 p.m. on May 20, 2006, and to the Unit 1 6.9kV busses at 8:40 p.m. Due to existing lockouts on the 1A and 2B main transformers, full realignment of breakers to provide offsite power to the vital busses and securing of all four diesel generators did not occur until approximately 1:10 a.m. on May 21, 2006. The NOUE was terminated at 1:45 a.m. on May 21, 2006.

In an unrelated event, on May 22, 2006, water overflowing from the Unit 2 cooling towers due to clogged screens entered the 1A diesel generator (DG) room through unsealed electrical conduits resulting in the 1A DG being declared inoperable. Following conduit seal repairs, inspection of DG support equipment and functional testing, the 1A DG was returned to operable status on May 24, 2006.

### **Inspection Scope**

Based on the probabilistic risk and deterministic criteria specified in Management Directive 8.3, "NRC Incident Investigation Program," Inspection Procedure 71153, "Event Followup," and the significance of the operational events which occurred, an Augmented Inspection was initiated in accordance with Inspection Procedure 93800, "Augmented Inspection Team."

The inspection focus areas included the following charter items:

- Develop a complete sequence of events, including applicable management decision points, from the time the LOOP occurred until both units were stabilized.
- Identify and evaluate the effectiveness of the immediate actions taken by the licensee in response to this event including the accuracy and timeliness of the licensee's classification of the event.

- Identify additional actions planned by the licensee in response to this event, including the time line for their completion of the investigation and follow-on analysis.
- Assess the circumstances surrounding the multiple lifting and reseating of the Unit 1 and Unit 2 pressurizer power operated relief valves.
- Determine if there are any generic issues related to this event which warrant an additional NRC response. As part of this review, assess the implications of a common cause failure of the emergency diesel generators due to external flooding. [Added to the charter after the May 22 event.] Promptly communicate any potential generic issues to regional management.

#### 4. OTHER ACTIVITIES

##### 4OA5 Augmented Inspection (93800)

##### .1 Develop a complete sequence of events, including applicable management decision points, from the time the LOOP occurred until both units were stabilized.

##### a. Inspection Scope

For the purposes of this Augmented Inspection, the team divided the charter element into three separate sequences of events; 1) electric plant response, 2) integrated plant response and 3) Emergency Response Organization response. The inspection team reviewed unified control room logs, operator aid and plant computer alarm and data logs, sequence of event recorder reports, and an event chronology developed by licensee personnel. The inspection team also interviewed several licensee and Duke Energy Power Delivery Department (i.e., Transmission) personnel in order to validate and further establish the sequence of events.

For the purpose of this inspection, “Unit Stabilization” was defined as follows:

- Electrical systems response - All diesels running, the load sequencer operation completed and safety loads re-energized from the diesel generators.
- Integrated plant response - Unit 1 stabilized in Mode 5 on Residual Heat Removal (ND) due to issues related to reactor coolant pump motor cooling caused by biological debris fouling. Unit 2 stabilized in Mode 3 with forced circulation and secondary side heat removal restored to the main condenser via steam dumps.
- Emergency Organization response - Termination of the Notice of Unusual Event.

##### b.1 Electrical Systems Response:

A list of the significant electrical plant events and time stamps is provided in Attachment 8, “Electrical Plant Sequence of Events.”



On 20 May 2006 at 2:01 p.m. EDT, a phase-to-ground electrical fault within the current transformer (CT) on the Catawba Unit 1 main step-up transformer 1A line position occurred within the 230kV switchyard resulting in a Loss of Offsite Power (LOOP) event for both Unit 1 and Unit 2. The entire sequence of events progressed so rapidly as to preclude any possible operator response to prevent the end result, but the sequence of events is presented in order to facilitate its understanding.

Actual Electrical Plant Response to the Event (See the simplified diagram of the Catawba main generator, transformers, and switchyard in Attachment 6 for specific breaker and relay locations):

The initial event that occurred was an internal fault in the X-phase CT associated with Power Circuit Breaker (PCB) 18.

Initial indications of neutral overcurrent (74TM) on all four main step-up transformers and overcurrent on both generators' X and Z phase windings were received by the plant computer. Fault protection provided by the Unit 1 A main step-up transformer differential protective relaying, as well as bus differential protective relaying actuated, resulting in the following breakers opening:

- Yellow bus (87BY) differential - PCB's 15, 18, 21, 24, 27, 30 and 33 (\*)
- Red bus (87BR) differential - PCB's 10, 13, 16, 19, 22, 25, 28 and 31
- Zone 1A (86A) lockout - PCB's 18 (repeat signal), 17 and Main Generator Circuit Breaker (GCB) 1A

\* It could not be confirmed that PCB 12 opened during the event. The breaker was subsequently demonstrated to be able to cycle by both Transmission System and Catawba Nuclear Station personnel. The station's corrective action program was scheduled to conduct additional testing and relay checks to verify that the breaker is fully functional.

The X-phase CT fault on PCB 18 induced a subsequent fault on the secondary side coils of the Y-phase CT associated with PCB 23. This coil provides an input to the Unit 2 B main step-up transformer differential protective relaying and resulted in its actuation causing the following breakers opening:

- Zone 2B (86B) lockout - PCB's 23, 24 (repeat signal) and GCB 2B

Both units received a runback signal which would have reduced electrical output to 48% as designed; however, this rapid sequence of events left Unit 1 attempting to feed 100% of its output through PCB 14 to the Newport Tie Station down the Allison Creek Black transmission line. This line was designed to carry 56% of rated station output (one hour summer rating). The Allison Creek Black line remote end breaker tripped at the Newport tie-station on over current and PCB 14 tripped open approximately 18 seconds later. The exact cause of the PCB 14 breaker trip was still under investigation.

Unit 2 was attempting to feed 100% of its output through PCB 20 to the Pacolet Tie Station down the Roddey Black transmission line. This line was designed to carry 56% of rated station output (one hour summer rating). The Roddey Black line distance (21) relay actuated, opening the remote end breakers and tripping PCB 20.

The Unit 1 and Unit 2 blackout logic was initiated upon loss of the 4.16kV bus because undervoltage conditions existed on all four of the vital electrical busses. All four diesel generators received auto-start signals. They were loaded by the blackout load sequencers and the safety loads were loaded back onto the vital busses and re-energized in their designated load groups per design.

#### Design Electrical Plant Response to the Event:

If the actual relay settings in the switchyard had been set appropriately, the event would have been limited to the actuation of main step-up transformer 1A differential protective relaying and the Yellow bus differential protective relaying to address the fault on the X-phase of the CT associated with PCB 18. Actuation of the main step-up transformer 2B differential protective relaying would have occurred to address the fault on the Y-phase of the CT associated with PCB 23. This would have resulted in the following breakers opening:

- Yellow bus (87BY) differential - PCB's 12, 15, 18, 21, 24, 27, 30 and 33
- Zone 1A (86A) lockout - PCB's 18 (repeat signal), 17 and GCB 1A
- Zone 2B (86B) lockout - PCB's 23, 24 (repeat signal) and GCB 2B

Both units would have runback to 48% main generator electrical output. In combination with the number of transmission lines available, the design of the switchyard should have prevented Units 1 and 2 from losing offsite power.

#### b.2 Integrated Plant Response:

A detailed time line of events and time/date stamps is provided in Attachment 10, "Integrated Plant Response Sequence of Events."

On 20 May 2006 at 2:01 p.m. EDT, a phase-to-ground electrical fault within the current transformer on the Catawba Unit 1 main step-up transformer 1A line position occurred within the 230kV switchyard resulting in a Loss of Offsite Power (LOOP) event for both Unit 1 and Unit 2. Both reactors tripped from 100 percent power, as expected. Control room operators entered emergency operating procedure EP/1(2)/A/5000/E-0, Reactor Trip or Safety Injection, for both units and then transitioned to emergency operating procedure EP/1(2)/A/5000/ES-0.1, Reactor Trip Response.

The first-out annunciator on Unit 1 indicated the reactor trip was caused by an "NI Hi Flux Rate Power Range" signal. Subsequent analysis of plant data determined that the

actual cause of this signal was from an electrical perturbation on the instrument bus resulting from the large fault in the switchyard. It was confirmed that an actual increase in reactor power significant enough to have generated an "NI Hi Flux Rate - Power Range" signal did not occur prior to the transient and reactor trip. All other expected reactor trip signals for the conditions present were received.

The first-out annunciator on Unit 2 indicated that the reactor trip was caused by actuation of the under frequency relays associated with the reactor coolant pump electrical busses. This is an expected reactor trip signal for the condition present.

All reactor trip breakers opened as expected and all control rods fully inserted into the core on the two units.

Both main turbines tripped upon receipt of the reactor trip signals. Following the loss of all offsite electrical power, the four (4) emergency diesel generators started and supplied power to the 4.16kV vital busses. Designated vital equipment was re-energized in accordance with the plant design through the diesel generator load sequencers. Operators implemented Abnormal Operating Procedure AP/1(2)/A/5500/007; Loss of Normal Power, to respond to the electrical transient.

A NOUE was declared at 2:14 p.m. on May 20, 2006, due to the loss of AC electrical power from all offsite sources for more than 15 minutes with onsite power available. The TSC, OSC, and subsequently the EOF were all activated on a precautionary basis.

The auxiliary feedwater pumps (3 per unit) started automatically to maintain water levels in the steam generators following the loss of the main feedwater pumps. Secondary-side pressure control transitioned from the steam dumps to the steam generator power operated relief valves (PORV's) once steam generator pressure dropped below 775 psig and a main steam line isolation signal was generated. Two of the three pressurizer PORV's on Unit 1 and one of the three PORV's on Unit 2 cycled during the initial phase of the transient to maintain primary system pressure.

The Technical Specifications for several safety-related systems required both on and offsite power to be available. The loss of the offsite power sources placed both units in Technical Specification 3.0.3 necessitating a natural circulation cooldown be performed in order to be in Mode 4 within 14 hours of the initiating event. Operators entered emergency procedure EP/1(2)/A/5000/ES-0.2; Natural Circulation Cooldown; and proceeded to reduce primary pressure and temperature in accordance with the guidance contained in the procedures. Once offsite power had been re-established, the cooldown was terminated and the units stabilized at approximately 470F and 1850 psig.

Power was restored to the Unit 2 6.9kV busses at 8:27 p.m. on May 20, 2006, and to the Unit 1 6.9kV busses at 8:40 p.m. Due to lockouts on the 1A and 2B main transformers, full realignment of breakers to provide offsite power to the vital busses and securing of all four diesel generators did not occur until approximately 1:10 a.m. on May 21, 2006. The Notice of Unusual Event was terminated at 1:45 a.m. on May 21, 2006.

Reactor Coolant Pumps were started to re-establish forced circulation on Unit 1 at 3:20 p.m. on May 21, 2006. Due to biological debris fouling of the Unit 1 reactor coolant pump motor coolers, all reactor coolant pumps were secured on May 22, the unit cooled down to Mode 5 on natural circulation and the residual heat removal system placed in-service. Following resolution of all issues required for restart, Unit 1 was returned to service on June 10, 2006.

Forced circulation was re-established on Unit 2 at 11:06 a.m. on May 21, 2006 and the unit remained in Mode 3 until all issues tied to restart had been resolved. Unit 2 was returned to service on May 26, 2006.

b .3 Emergency Response Organization Response:

A detailed time line of Emergency Response Organization actions is provided in Attachment 9, "Emergency Response Organization Sequence of Events."

On May 20, 2006 at 2:01 p.m. EDT, a phase-to-ground electrical fault within the current transformer on the Catawba Unit 1 main step-up transformer 1A line position occurred within the 230kV switchyard resulting in a Loss of Offsite Power (LOOP) event for both Unit 1 and Unit 2. The Operations Shift Manager (OSM) declared a Notice of Unusual Event at 2:14 p.m. based on the existing Emergency Plan entry condition of the loss of all offsite power to essential busses for greater than 15 minutes with all emergency diesel generators supplying power to their respective 4.16kV busses.

The Control Room Offsite Agency Communicator made the required initial verbal notifications to local and State agencies. The notification to York County Emergency Management (EM) was delayed due to a problem with the selective signal system. The problem was subsequently traced to a blown fuse in York County's system. York County emergency response personnel were notified via a second phone call during which the event declaration information was read over the phone and transcribed remotely.

The first follow-up update was also made by the Control Room Offsite Agency Communicator; however, the notifications took longer than usual because the loss of non-essential power resulted in the control room fax machines being unavailable. The communicator was required to call the individual offsite agencies and read the notification message to the state and county warning point telecommunicators while that person wrote down the information on a blank notification form. The loss of the fax capabilities resulted in the follow-up update being completed within 74 minutes of the initial notification versus the expected 60 minute time period (a 4 hour requirement for follow-up notifications exists).

The OSM activated the TSC and OSC as a precautionary measure to ensure any necessary resources were readily available on-site to respond to the LOOP event. The TSC and OSC were activated at 3:50 p.m. at which time responsibility for offsite agency

communications was transferred to the TSC from the Control Room Offsite Agency Communicator. During the event, the NRC Operations Center was not notified within one hour of the initial NOUE declaration as required by 10 CFR 50.72(a)(3). This oversight was identified by TSC personnel and the NRC Operations Center was notified of the event at 4:15 p.m., which was 61 minutes late. The NRC Resident Inspectors had been notified at 2:14 p.m. as part of the initial Emergency Response Organization pager call-out and had responded to the site within 30 minutes of this notification.

The EOF was activated at 6:19 p.m. at the request of the TSC Emergency Coordinator. The EOF staff provided support to the site by assuming the responsibility for offsite agency communication. Hourly updates were provided to state and local agencies, as required, by the EOF staff.

At 1:45 a.m. on May 21, 2006, after offsite power was restored to all four 4.16kV essential busses, the NOUE was terminated. The EOF, TSC, and OSC organizations were released and the Outage Control Center was staffed to support stabilization and recovery activities for both units.

Additional assessment of the timeliness of the licensee's emergency response organization response to the LOOP is required and identified as Unresolved Item (URI) 05000413, 414/2006009-01, Timeliness of Notification to the NRC of Loss of Offsite Power Event on May 20, 2006.

.2 Identify and evaluate the effectiveness of the immediate actions taken by the licensee in response to the LOOP event including the accuracy and timeliness of the licensee's classification of the event

a. Inspection Scope

The inspectors evaluated the response of the licensee's staff to the LOOP from the start of the event until the NOUE was terminated through the review of logs, completed procedures and statements, conducting interviews with Operations and Emergency Response Organization personnel, as well as actual observations of recovery activities in the control room, Operations Support Center, and Technical Support Center immediately following the event conducted by the Catawba Resident Inspectors.

b. Findings and Observations

The LOOP event started at 2:01 p.m. on Saturday, May 20, 2006. Therefore, the site was staffed at weekend levels; i.e., limited engineering, maintenance and support staff available. The on-shift crew responded to the event through actions in the control room by licensed operators and throughout the plant by non-licensed operators. Additional support was provided by all other available on-site personnel prior to the arrival of the staff called out as part of the Emergency Response Organization. A second Senior Reactor Operator (SRO) in the control room allowed an SRO to be dedicated to each unit in order to direct the actions dictated by the Emergency Operating procedures implemented following the LOOP and reactor trips. While the operators experienced

some minor equipment malfunctions, the procedures in-use allowed them to respond to those issues and stabilize plant conditions on both units.

The OSM declared a NOUE at 2:14 p.m. due to the loss of all offsite power for greater than 15 minutes with onsite power available. The decision to declare a NOUE was made 2 minutes prior to meeting the actual Emergency Plan entry conditions based on the recognition that offsite power would not be imminently restored. The Emergency Response Organization was notified by pager at that time and instructed to activate the TSC and OSC on a precautionary basis. Both of these facilities were staffed and activated by 3:50 p.m. and the responsibility for communicating with offsite agencies was assumed by TSC personnel. The EOF was activated at the request of the TSC Emergency Coordinator at 6:19 p.m.

Overall, operator response to the LOOP event was deliberate and effective in stabilizing the units and restoring offsite power through the use of approved station procedures. The Emergency Response Organization responded to the event promptly. With the exception of initial NRC Operations Center notification as discussed in Section 4OA5.1.b.3, the Emergency Planning program was successfully implemented from initial declaration of the NOUE until the event was terminated following restoration of offsite power to all 4.16kV vital electrical busses.

.3 Identify additional actions planned by the licensee in response to this event, including the time line for their completion of the investigation and follow-on analysis

a. Inspection Scope

The inspectors reviewed the licensee's Trip and Transient Investigation report for each unit. An independent review of operator aid computer data, control room logs, emergency response organization logs, PIP's and work orders was performed to determine if all equipment-related issues following the loss of offsite power event were identified and properly prioritized. Discussions were held with members of the station's Failure Investigation Process (FIP) Team as well as the corporate Special Event Investigation Team (SEIT) conducting an independent review of the event.

b. Findings and Observations

The licensee developed unit-specific action item lists following the LOOP event. The lists identified actions that were either required to be completed prior to the restart of each unit or were either generic in nature or required additional time to complete and not required for restart.

The following tables contain a summary of equipment-related issues that were identified following the loss of offsite power event of May 20, 2006 and the 1A diesel generator room flooding of May 22, 2006, if they were required to be resolved prior to restart and the actions taken by the licensee to address them. Due to the extent of actions tied to the electrical plant following the LOOP, those issues are contained in a separate table.

UNIT 1 : Non-Electrical Issues			
Issue	Details	Req. for Restart	Status
Initial reactor trip signal was on Hi Flux Rate; however, actual conditions for this signal did not exist.	The signal was attributed to an electrical perturbation caused by the power range NI grounding system. This response was seen on a previous LOOP at Catawba 1	NO	PIP C-06-3874 was initiated to conduct an Apparent Cause assessment into the cause of the signal.  (PIP C-06-3874)
Loop B hot leg RTD card failed several minutes into the event	The cards required replacement and calibration.	YES	The cards were replaced and recalibrated.  (WO 98790462 / PIP C-06-3879)
Excess letdown control valve 1NV-122 would not open following the reactor trip	The valve was repaired and stroked successfully.	YES	Repairs were completed  (PIP C-06-3873)
Normal letdown variable orifice control valve failed to re-open following event	The valve has been repaired and stroked successfully.	YES	Repairs have been completed  (WR 98375944)
1D steam generator PORV was slow to open	The positioner required recalibration	YES	Repairs were completed.  (PIP C-06-3883)
Unsealed electrical conduits resulted in flooding of the 1A DG room	Conduits between the cooling tower cable trench and RN conduit manhole CMH-04A were not sealed per design drawings. Conduits between CMH-3 and the 1A DG room were not sealed per design drawings.	YES	All penetrations into the Unit 1 A and B diesel generator rooms were sealed per construction drawings.  (PIP C-06-3902)

UNIT 1 : Non-Electrical Issues			
Issue	Details	Req. for Restart	Status
"A" Control Area chilled water chiller failed to auto start following the event	A loose wire on the Program Timer within the chiller control panel was found.	YES	Wiring was reterminated.  (WO 98791173 / PIP C-06-4037)
Motor stator coolers for the reactor coolant pumps and the LCVU coolers exhibited restricted flow following the event	On a loss of offsite power the normal cooling source (YV) swapped to the backup source (RN). Debris in no-flow sections on the RN piping was flushed into the motor stator coolers and LCVU coolers requiring disassembly and cleaning.	YES	All 4 reactor coolant pump motor stator coolers and LCVU coolers were cleaned.  (PIP C-06-3935)
1A1 and 1A2 WN sump pumps in the 1A DG room failed following being submerged after conduit flooding event	The two sump pumps were totally submerged after the 1A DG room flooded. The motors required replacement.	NO	The motors were replaced and tested.  (WO 98791331)

UNIT 2 : Non-Electrical Issues			
Issue	Actions	Req. for Restart	Status
Digital Feedwater Control System driver card for the 2B CFPT failed and switched to the backup card	The primary card needs to be replaced and functional test performed.	NO	Primary card has been replaced and calibrated.  (PIP C-06-3897)
Zone B lockout occurred following the reactor trip	The Y Phase current transformer associated with PCB 23, and specifically the secondary winding utilized in the Zone 2B differential protection circuit actuated during the LOOP, was found to be damaged during a current transformer saturation test.	NO	The current transformer for PCB 23 Y Phase was replaced with a new unit that was stored in the CNS Switchyard  (PIP C-06-4089)



UNIT 2 : Non-Electrical Issues			
Issue	Actions	Req. for Restart	Status
DRPI indication for rods H4 and D8 did not go to zero following the reactor trip	Subsequent review determined that the indication was for the OAC only.	NO	Problem found on a digital input card in the OAC. Card was reset and indication problems cleared.  (PIP C-06-3881)
Tavg indication drifted high following the reactor trip	Tavg NSA card determined to require recalibration	YES	Recalibration performed prior to restart.  (PIP C-06-3991)
VCT relief valve failed to open at its 75 psig setpoint	The VCT pressure reached 92 psig during the event. An analysis was performed to assess the structural integrity impact due to this pressure transient.	YES	Analysis showed that the integrity of the tank and piping was not adversely affected. No replacement of the valve was planned.  (PIP C-06-3927)
"A" Control Area chilled water chiller failed to auto start following the event	A loose wire on the Program Timer within the chiller control panel was found.	YES	Wiring has been reterminated.  (WO 98791173 / PIP C-06-4037)

Station Electrical Issues			
Issue	Actions	Req. for Restart	Status
Due to the electrical fault, possible damage may have occurred to the CT's on PCB's 17 & 18	Perform Doble and/or Saturation testing on X, Y, and Z phases of PCB's 17 and 18	YES	All 3 phases of PCB 17 and 18 were Doble tested; however, Saturation testing was not found to be required on PCB 17.  WO 9879052 WO 9879053 WO 9879054
The CT on the X phase of PCB 18 failed, initiating the LOOP event	Replace the X-phase CT on PCB 18 and any other damaged components	YES	The CT and associated wiring / conduits were replaced.  WO 98790418
Based on OE from MNS, the potential for degradation of the MOD contacts following a fault on the transmission line existed	Visually inspect the disconnects associated with PCB 17's and 18	YES	Visual inspections completed and no repairs required.  WO 98790594 WO 98790593 WO 98790581 WO 98790580
Inspect PCB's 17 and 18 for damage or excessive build-up of arc extinguishment "salt"	Perform Doble testing and visual inspections of the PCB's	YES	Doble testing performed satisfactorily, cleaned arcing contacts and replaced main contacts.  WO 98790416 WO 98790417

Station Electrical Issues			
Issue	Actions	Req. for Restart	Status
Zone 2B Protective Relays need to be tested to verify calibration following the LOOP	Relay calibrations were required and visual inspections of connections were performed to ensure no degradation exists	YES	All relays were found to be satisfactory in the "as-found" condition. No other repairs were required.  WO 98790852
Differential relays were not set in IAW Power Delivery requirements	Verify current differential relays on the Red and Yellow busses and adjust as required to meet Power Delivery requirements	YES	The 87BY X-Y-Z (Yellow bus) and 87BR X-Y-Z (Red bus) differential relays were checked and reset as required.  WO 98790851 WO 98790853 WO 98790443
Determine why the 2B Zone Lockout occurred	Based on Engineering recommendations, several tests were performed on the 2B transformer	YES	After disconnecting the high and low side of the transformer, the post-trip Doble test was completed satisfactorily. The transformer was demagnetized as the excitation results were not within the normal range. All tests were Satisfactory at the completion.  WO 98790412 WO 98790413 WO 98790414 WO 98790415

Station Electrical Issues			
Issue	Actions	Req. for Restart	Status
Ensure there is no issue related to the 1A transformer following the LOOP event	Perform post-trip Doble testing to ensure no problems exist following differential actuation	YES	Testing indicated that there were no problems with the 1A transformer  WO 98790430
The MOD was not opened within 1 hour of the individual PCB's opening which may have resulted in the degradation of grading capacitors in the interrupter heads.	Perform post-trip Doble tests on individual PCB's to ensure no degradation occurred. PCB's 14, 17, 18, 20, 23, and 24 were tested.	YES	Doble testing completed satisfactorily  WO 98790433 WO 98790434 WO 98790435 WO 98790436 WO 98790437 WO 98790438
Investigate the cause of the PCB 18 CT failure.	Gas concentration of several PCB's scheduled to be checked based on past history and issues related to moisture intrusion into CT's. PCB's to be checked include PCB 14, 15, 17, 18, 20, 21, 23 and 24	NO	Testing was in progress, no issues found to-date.  WO 98790585 WO 98790586 WO 98790587 WO 98790588 WO 98790589 WO 98790590 WO 98790591 WO 98790592
Copper splatter was found on the neutral bushing of the 2B Main S/U transformer due to the fault current	The neutral bushing required cleaning following experiencing the high fault current associated with the event	YES	The bushing was cleaned  WO 98791075

Station Electrical Issues			
Issue	Actions	Req. for Restart	Status
During the investigation into the Unit 2 2B lockout, Power Delivery recommended that testing be conducted	The CT's for the X, Y and Z phases on PCB's 23 and 24 were isolated and tested to check for damage	YES	All 3 CT's on PCB 24 tested satisfactorily. The Y phase CT on PCB 23 failed and was replaced. No other problems were identified.  WO 98791140 WO 98791142

.4 Assess the circumstances surrounding the multiple lifting and reseating of the Unit 1 and Unit 2 primary power operated relief valves (PORVs)

a. Inspection Scope

Inspectors assessed the circumstances surrounding the multiple lifting and reseating of the Unit 1 and Unit 2 pressurizer PORVs to determine if the PORVs responded appropriately during the event. System Engineering personnel were interviewed and design documents and calibration procedures were reviewed to support this assessment.

b. Findings and Observations

Each unit is equipped with three pressurizer PORVs. The PORVs are air operated valves each having a relief capacity of 210,000 lbm/hr at a nominal lift setpoint of 2,335 psig. The PORVs are designed to maintain primary plant pressure below the pressurizer pressure high reactor trip setpoint of 2,385 psig following a step reduction of 50% of full load with steam dump operation. The PORVs minimize challenges to the pressurizer safety valves and may also be used for low temperature over pressure protection (LTOP). The PORVs and their associated block valves may also be used by plant operators to depressurize the reactor coolant system (RCS) to recover from certain transients if normal pressurizer spray is not available.

During a LOOP, normal pressurizer spray is not available due to a loss of all reactor coolant pumps. Primary system pressure control is then automatically provided via the PORVs and the pressurizer pressure master controller. The pressurizer pressure master controller is a "proportional plus integral" (P-I) controller with a nominal PORV setpoint designated as  $P_{ref}$  of 2,235 psig. As primary system pressure increases during a LOOP event, the pressurizer pressure master controller will cycle one PORV (NC-34A) over a 20 psig band to return RCS pressure to a nominal  $P_{ref}$  setpoint of 2,235 psig. The other two PORV's will lift when pressure reaches their respective lift setpoints.

Specific to the May 20, 2006 LOOP event, Unit 1 PORVs 1NC-32B and 1NC-34A actuated appropriately. 1NC-34A cycled in automatic a total of 57 times as the P-I controller attempted to return RCS pressure to the 2,235 psig  $P_{ref}$  setpoint. PORV 1NC-32B cycled a total of five times as RCS pressure exceeded its 2,335 psig lift setpoint. The Unit 2 PORV, 2NC-34A automatically cycled a total of 35 times as the P-I controller attempted to return RCS pressure to the 2,235 psig  $P_{ref}$  setpoint. The total number of cycles differs between the units due to Unit 1's higher initial pressurizer level and subsequent higher pressurizer pressure and the associated recovery time required to re-establish normal RCS letdown flow. Graphs showing the pressurizer pressure versus time following the LOOP for both units which demonstrate how the PORV's were operating to return pressure to the  $P_{ref}$  setpoint are provided as Attachment 7.

A comparison of the May 20, 2006 plant response to historical data obtained from a 1996 Unit 2 LOOP event was conducted. This review revealed similar and consistent PORV cycling to maintain RCS pressure for the similar event.

In summary, the PORVs on both units operated as designed to control primary plant pressure.

- .5 Determine if there are any generic issues related to this event which warrant an additional NRC response. As part of this review, assess the implications of a common cause failure of the emergency diesel generators due to external flooding. Promptly communicate any potential generic issues to regional management.
- a. Inspection Scope

During the inspection team's investigation into the event; equipment issues, procedures, and design documents were reviewed to determine if there were any generic issues that required additional review by NRC personnel. In addition, the partial flooding of the 1A diesel generator room that occurred on May 22, 2006 was also reviewed by the team for generic implications.

The inspectors reviewed unified control room logs, operator aid and process computer alarm logs, sequence of event recorder reports, emergency response organization logs from the TSC, OSC and EOF, statements from individuals involved in the event and timelines developed by licensee personnel. The inspectors also interviewed licensee personnel to validate and clarify the sequence of events which occurred on May 20, 2006. Notes generated by the Resident Inspectors who responded to the event and were in the control room, OSC, and TSC until the NOUE was terminated were also reviewed. To identify potential generic implications of the events, the Final Safety Analysis Report (FSAR), design basis documents, Catawba calculations, relay setpoint sheets from the Power Delivery Department, 10 CFR 50 Appendix A, "General Design Criteria", and corrective action program documents were reviewed by the inspection team members.

### b.1 Switchyard Design and Relay Settings

The inspectors reviewed the design of the offsite power system for compliance with the requirements of 10 CFR 50, Appendix A, General Design Criterion 17. This criterion requires two physically independent circuits from the transmission network to the onsite electrical distribution system, with one of these circuits being available within a few seconds following a loss-of-coolant accident to ensure that core cooling, containment integrity, and other vital safety functions are maintained. The team found no regulatory issues with the overall as-designed switchyard configuration nor theory of operation.

However, the Red bus differential relay actuation, resulting in opening of all the 230 KV switchyard Red bus tie-breakers was apparently caused by incorrect setting of the relays. This issue remains unresolved pending further inspection to review the root and contributing causes, the extent of condition, and the corrective actions, specifically the latent presence of inappropriate setpoints in the bus differential relaying associated with the Red and Yellow buses. It is identified as URI 05000413, 414/2006009-02, Improper relay settings in the Catawba 230kV switchyard resulted in a total loss of offsite power following failure of a PCB current transformer.

The licensee determined that the differential relays had not been set in accordance with the relay setpoint calculations developed in 1981 by Duke Energy's Power Delivery Department. The setpoints had been developed in 1981, which was prior to commercial operation of either Catawba unit and the establishment of site System Engineering.

### b.2 Description of 1A Diesel Generator Room Flooding Event

On May 22, 2006, the control room was notified of water flooding into the 1A DG room. Operators were dispatched and identified that the flooding was coming in through below-grade electrical conduits on the south wall. The source of the water was determined to be overflow from the Unit 2 cooling towers, through the cooling tower cable trench, into two safety-related manholes and finally into the 1A DG room. Once the cooling towers had been secured, the in-leakage stopped. The conduits into the manholes and the 1A DG room were found not to be sealed as required per design and construction documents.

The water flowed over the starting air compressors, DG battery enclosure, and load sequencer cabinets, and collected in the DG sump. The rate of flooding exceeded the capacity of the installed DG sump pumps. Additional sump pumps had to be brought in to keep the water from reaching the lube oil sump tank and the generator. Neither of these components were wetted.

The 1A DG was declared inoperable and the applicable Technical Specifications were entered. An operability assessment and several additional inspections were required to be performed prior to declaring the diesel generator operable. In addition, the electrical conduits entering manhole CMH-4A from the cooling tower cable trench and those entering the 1A DG room from manhole CMH-3 were sealed in accordance with design drawings.

Inspections were performed on all other electrical conduits that entered the auxiliary building through below-grade penetrations to ensure they were properly sealed. Approximately 45 electrical conduits required repairs of the moisture seals to restore them to their as-built design condition.

The team identified Unresolved Item 05000413/2006009-03 to review the root and contributing causes, the extent of condition, and the corrective actions associated with the failure to seal conduits into manholes and the 1A DG room as required by design and construction documents.

The team also identified Unresolved Item 05000413, 414/2006009-04 to review the extent of condition and corrective actions taken to address degraded seals found on below-grade electrical conduits entering areas of the auxiliary building containing safety-related equipment.

#### 4OA6 Meetings

##### Exit Meeting Summary

On May 26, 2006, the inspection team presented the preliminary inspection results to Mr. Jamil and members of his staff of the Augmented Inspection in progress. On May 31, 2006, the Region II Director, Division of Reactor Projects, the Augmented Inspection Team Leader and the Catawba Senior Resident Inspector presented the results of the inspection in a public meeting at the Rock Hill City Hall to Mr. Jamil and other members of his staff. Mr. Jamil acknowledged the findings and observations of the team at that time. All proprietary information reviewed by the team was returned to the licensee.

#### ATTACHMENT - SUPPLEMENTAL INFORMATION

1. Key Points of Contact
2. List of Items Opened, Closed and Discussed
3. List of Documents Reviewed
4. List of Acronyms
5. Augmented Inspection Team Charter
6. Catawba Main Generator, Transformers, and 230kV Switchyard Simplified Diagram
7. Unit 1 and Unit 2 Pressurizer Pressure Traces
8. Electrical Plant Sequence of Events
9. Emergency Response Organization Sequence of Events
10. Integrated Plant Response Sequence of Events



## **SUPPLEMENTAL INFORMATION**

### **KEY POINTS OF CONTACT**

#### **Licensee**

E. Beadle, Emergency Planning Manager  
G. Black, Civil System Engineer  
J. Caldwell, I&C / Electrical Maintenance Manager  
K. Caldwell, Electrical System Engineer  
T. Daniels, Emergency Planning  
A. Dickard, Senior Engineer, Electrical Systems  
A. Dubois, Power Deliver Services (PDS)  
J. Ferguson, Safety Assurance Manager,  
R. Freudenberger, EIT Leader  
G. Hamrick, Mechanical / Civil Engineering Manager  
R. Hart, Regulatory Compliance  
J. Herrington, Senior Engineer, Primary Systems  
W. Hogan, Fire Protection Engineer, MCE  
D. Jamil, Site Vice President  
K. Lyle, FIP Team Leader  
S. Mays, Reactor Coolant System Engineer  
G. Mitchell, Emergency Planning  
V. Paterson, Public Relations  
M. Patrick, Work Control Superintendent  
T. Pitesa, Station Manager  
T. Ray, Maintenance Superintendent  
R. Repko, Engineering Manager  
R. Smith, Emergency Planning  
G. Strickland, Regulatory Compliance Specialist  
K. Thomas, Corporate Manager, Regulatory Compliance, SEIT Leader  
C. Trezise, Operations Superintendent  
T. Wingo, System Engineer

#### **NRC**

C. Casto, Director DRP, Region II  
C. Payne, Acting Branch Chief, Region II, Branch 1  
J. Stang, Project Manager, NRR  
W. Travers, Region II Regional Administrator  
W. Rogers, RII Senior Reactor Analyst

## LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

### Opened

05000413, 414/2006009-01	URI	Timeliness of Notification to the NRC of Loss of Offsite Power Event on May 20, 2006.(Section 4OA5.1.b.3)
05000413, 414/2006009-02	URI	Improper relay settings in the Catawba 230kV switchyard resulted in a total loss of offsite power following failure of a PCB current transformer (Section 4OA5.5.b.1)
05000413/2006009-03	URI	Review of failure to seal conduits into manholes and the 1A DG room as required by design and construction documents (Section 4OA5.5.b.2)
05000413, 414/2006009-04	URI	Review the extent of condition and corrective actions to address degraded seals on below-grade electrical conduits entering the auxiliary building (Section 4OA5.5.b.2)

## **LIST OF DOCUMENTS REVIEWED**

### **Technical Specifications**

Catawba Nuclear Station UFSAR Chapter 5  
Catawba Nuclear Station Technical Specifications 3.4, 3.5, 3.8  
Catawba Nuclear Station Technical Specification Bases 3.4, 3.5, 3.8

### **Calculations / Specifications**

CNS-1465.00-00-0021, Design Basis Specification for the Plant and Offsite Power Protective Relaying, Rev. 0  
CNS-1553.NC-00-0001, Design Basis Specification for the Reactor Coolant (NC) System, Rev. 25  
CNS-1465.00-00-0005, Design Basis Specification for the Design Basis Event, Rev. 2  
CNC-1223.12-00-0051, Effect of PORV Operation on CLA Nitrogen Pressure and NI System Operability Calculation

### **Drawings**

CN-1938-01; Electrical Equipment Layout; Outdoor Area; General Plan  
CN-1938-04, 05, 06 and 07; Electrical Equipment Layout; Outdoor Area; Section and Details

### **Procedures / Surveillances**

EP/1/A/5000/E-0; Reactor Trip or Safety Injection; Rev. 27  
EP/1/A/5000/ES-0.1; Reactor Trip Response, Rev. 22  
EP/1/A/5000/ES-0.2; Natural Circulation Cooldown, Rev. 19  
AP/1/A/5500/007; Loss of Normal Power; Rev. 49  
AP/1/A/5500/012; Loss of Charging or Letdown; Rev. 23  
EP/2/A/5000/E-0; Reactor Trip or Safety Injection; Rev. 26  
EP/2/A/5000/ES-0.1; Reactor Trip Response, Rev. 22  
EP/2/A/5000/FR-1.1; Response to High Pressurizer Level, Rev. 11  
AP/2/A/5500/012; Loss of Charging or Letdown; Rev. 19  
AP/2/A/5500/007; Loss of Normal Power; Rev. 49  
PT/0/A/4150/002A; Transient Investigation; Rev. 0 (For Unit 1 and Unit 2)  
IP/0/B/3112/008; Calibration of RN System Conduit Manhole Sump Level Switches, Rev. 004  
IP/0/A/3850/013B; Procedure for Sealing Rigid Steel Field Run Conduit; Rev. 10  
EP/1/A/5000/E-0; Reactor Trip or Safety Injection, Rev. 027  
IP/1/B/3222/063; Calibration Procedure for Pressurizer Pressure Control, Rev. 027

## Miscellaneous Documents

Dow Corning 732 Multi-Purpose Sealant Product Data Sheet  
NSD-407, Maintenance Interface Agreement for Nuclear Generation, Electric Transmission, Information Management, and Power Generation Departments, Rev. 06  
NSD-409, Engineering Guidelines for Nuclear Station Switchyard and Main Step-Up Transformer Activities, Rev. 06  
NSD-502, Corporate Conduct of Operations in the Switchyard, Rev. 07

## Work Orders

WO 98791331; 1A1 and 1A2 WN sump pumps failed meggar testing following submergence when water drained from manhole CMH-3 into the 1A diesel generator room.  
WO 98790811; 2B Digital Feedwater Control System primary driver card failed and swapped to the backup card.  
WO 98766406; Remove hatches and inspect manholes CMH-18A and B  
WO 9879087; Seal conduits in CMH-18A  
WO 9879098; Seal conduits in CMH-18B

Work Orders associated with the switchyard and main generator activities

WO 9879052  
WO 9879053  
WO 9879054  
WO 98790418  
WO 98790594  
WO 98790593  
WO 98790581  
WO 98790580  
WO 98790416  
WO 98790417  
WO 98790852  
WO 98790851  
WO 98790853  
WO 98790443  
WO 98790412  
WO 98790413  
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 WO 98790589  
 WO 98790590  
 WO 98790591  
 WO 98790592  
 WO 98791075  
 WO 98791140  
 WO 98791142

### PIPs

PIP C-06-4180, Need to incorporate the pressurizer PORV operation into future training and Operating Experience  
 PIP C-06-4150, PORC meeting held on 5/29/06 for the restart of Unit 1  
 PIP C-06-4149, Operability assessment for the conduit between manholes CMH-2, 3, 18A and 18B and their respective diesel rooms due to the conduit now being sealed on both ends.  
 PIP C-06-4112, Questions / concerns raised over the inspections performed on conduit seals in manholes CMH-18A&B which required rework  
 PIP C-06-4106, Critique of the Trip and Transient process following the LOOP  
 PIP C-06-4089, Y Phase Current Transformer associated with PCB 23 found to be damaged.  
 PIP C-06-4087, Resident Inspector identified that spare conduits were to be stubbed out and capped per the drawing. Conduit was sealed instead. Need to resolve difference.  
 PIP C-06-4049, Action items from the PORC meeting held on 5/24/06 to discuss the cause(s) of the Unit 1 and Unit 1 LOOP event  
 PIP C-06-4037, PORC action items from plant transient investigation into the Unit 2 reactor trip following the LOOP on 5/20/06  
 PIP C-06-4012, E1 work request written to inspect cooling tower trenches for water barrier integrity  
 PIP C-06-4007, E1 work request written to inspect and seal conduit sleeves for CMH-16B  
 PIP C-06-3983, E1 work requests written to inspect essential cabinets for water intrusion after 1A diesel generator flooding  
 PIP C-06-3947, E1 work request issued to repair the 1A DG prelube pump which will not start  
 PIP C-06-3941, Power Delivery questioned the testing methods used at Catawba for transformer saturation testing  
 PIP C-06-3934, Need to assess the flooding design basis for the RN conduit penetrations into the diesel generator rooms

PIP C-06-3902, Unit 2 cooling towers overflowed causing water intrusion into the 1A diesel generator room

PIP C-06-3893, Cooling towers overflowing excessively causing water to build up on the ground surrounding the towers

PIP C-06-3889, Reactor Engineering review of dual unit LOOP

PIP C-06-3886, Unit 2 containment walkdown inspection results

PIP C-06-3883, Steam Generator 1D PORV was slow to respond

PIP C-06-3874, Unit 1 reactor trip investigation following loss of offsite power

PIP C-03-3297, During the flush of 1B NS heat exchanger, the sump pump for the RN conduit manhole CMH-4A started pumping down

PIP C-03-2716, Inspection of structural components in site RN conduit manholes

PIP C-01-3842, Documentation of entries into RN conduit manholes

PIP C-06-3864, Unit 1 Loss of Offsite Power

PIP C-06-3865, Unit 2 Loss of Offsite Power

PIP C-06-3873, 1NV-122B (Excess letdown isolation) failed to open

PIP C-06-3880, 2NC-34A opened at lower pressure than setpoint during LOOP event

PIP C-06-3927, Unit 2 VCT Relief Valve (2NV223) did not function properly during dual unit Loss of Offsite Power event on 5/20/06

PIP C-06-4091, During the recent dual unit LOOP event, there was a similar drop in pressure of 17 psig in NI CLA 1A and 18 psig in NI CLA 2A. On both units, CLA pressure decreased after aligning N2 supply to the PZR PORVs 1(2)NC-34A. As identified below, the number of PZR PORV cycles for each unit 1 and 2 PZR PORV was incorrectly reported as 107 strokes and 35 strokes, respectively. This led the NRC to question reliable operation of unit 2 PZR PORV, 2NC-34A (due to similar N2 usage for significantly fewer cycles).

PIP C-96-0306, Pressurizer PORV Issues during Unit 2 LOOP

PIP C-95-1400, Calculation review identified potential grid/unit stability concerns. Analysis will be done to address these concerns

PIP C-01-1556, This PIP is to document an evaluation that has been initiated to determine if any elective NSM's should be originated for generator protection in the event of a three phase fault to ground, within ½ mile of CNS, in conjunction with a breaker failure to trip. This was previously identified in PIP C-95-01400

## LIST OF ACRONYMS

AC	Alternating Current
AIT	Augmented Inspection Team
AP	Abnormal Operating Procedure
CFPT	Main Feedwater Pump Turbine
CFR	Code of Federal Regulations
CLA	Cold Leg Accumulator
CMH	Conduit Manhole
DFCS	Digital Feedwater Control System
DG	Emergency Diesel Generator
DRPI	Digital Rod Position Indication
EIT	Event Investigation Team
EM	Emergency Management (off-site agencies)
EOF	Emergency Operations Facility
EP	Emergency Operating Procedure
ERO	Emergency Response Organization
FIP	Failure Investigation Process
FSAR	Final Safety Analysis Report
GCB	Generator Circuit Breaker
GDC	General Design Criteria
KV	Kilovolt
LCVU	Lower Containment Ventilation Unit
LOOP	Loss of Offsite Power
NCV	Non-Cited Violation
ND	Residual Heat Removal System
NOUE	Notice of Unusual Event
NRC	Nuclear Regulatory Commission
NV	Chemical Volume and Control System
OAC	Operator Aid Computer
OP	Normal Operating Procedure
OSC	Operations Support Center
OSM	Operations Shift Manager
PCB	Power Circuit Breaker
PIP	Problem Investigation Process (report)
PORV	Power Operated Relief Valve
RN	Nuclear Service Water System
RTD	Resistance Temperature Detector
SDP	Significance Determination Process
SEIT	Special Event Investigation Team
SOE	Sequence of Event Recorder
TSAIL	Technical Specification Action Item Log
TSC	Technical Support Center
URI	Unresolved Item
VCT	Volume Control Tank

WN	Emergency Diesel Room Sump Pump System
WO	Work Order
WR	Work Request
YC	Control Room Chilled Water System
YV	Containment Chilled Water System



May 25, 2006

MEMORANDUM TO: James H. Moorman, Chief  
Operations Branch  
Division of Reactor Safety

FROM: William D. Travers, Regional Administrator */RA/*

SUBJECT: REVISED AUGMENTED INSPECTION TEAM CHARTER

An Augmented Inspection Team (AIT) was established on May 23, 2006, for Catawba Nuclear Station to inspect and assess the facts surrounding a loss of offsite power (LOSP) and subsequent dual unit reactor trip at Catawba on or around May 20, 2006.

The team composition and the objectives of the inspection are unchanged. However, the enclosed charter has been revised to clarify and expand on the actions to be accomplished by Item "e" to assess the implications of a common cause failure of the emergency diesel generators due to external flooding.

For the period during which you are leading this inspection and documenting the results, you will report directly to me. The guidance in Inspection Procedure 93800, "Augmented Inspection Team," and Management Directive 8.3, "NRC Incident Investigation Program," applies to your inspection.

If you have any questions regarding the objectives of the enclosed revised charter, contact Charles A. Casto at (404) 562-4500.

Enclosure: AIT Charter

Docket Nos.: 50-413 and 50-414  
License Nos.: NPF-35 and NPF-52

Distribution:

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**REVISED AUGMENTED INSPECTION TEAM (AIT) CHARTER  
CATAWBA LOSS OF OFFSITE POWER AND DUAL UNIT REACTOR TRIP**

Basis for the Formation of the AIT - On May 20, 2006, an electrical fault occurred apparently causing several power circuit breakers (PCB's) to open in the Catawba switchyard. This fault apparently caused several other PCB's to open resulting in a loss of offsite power (LOSP) and trip of both Catawba reactors. In accordance with Management Directive (MD) 8.3, "NRC Incident Investigation Program," deterministic and conditional risk criteria were used to evaluate the level of NRC response for this operational event. The review concluded that the circumstances of the event met the MD 8.3 deterministic criteria due to an apparent single electrical failure causing a loss of offsite power to both operating units and reactor trips. The risk review indicated the CCDP for the event met the criterion for an Augmented Inspection. Subsequently, Region II determined that the appropriate level of NRC response was the conduct of an Augmented Inspection.

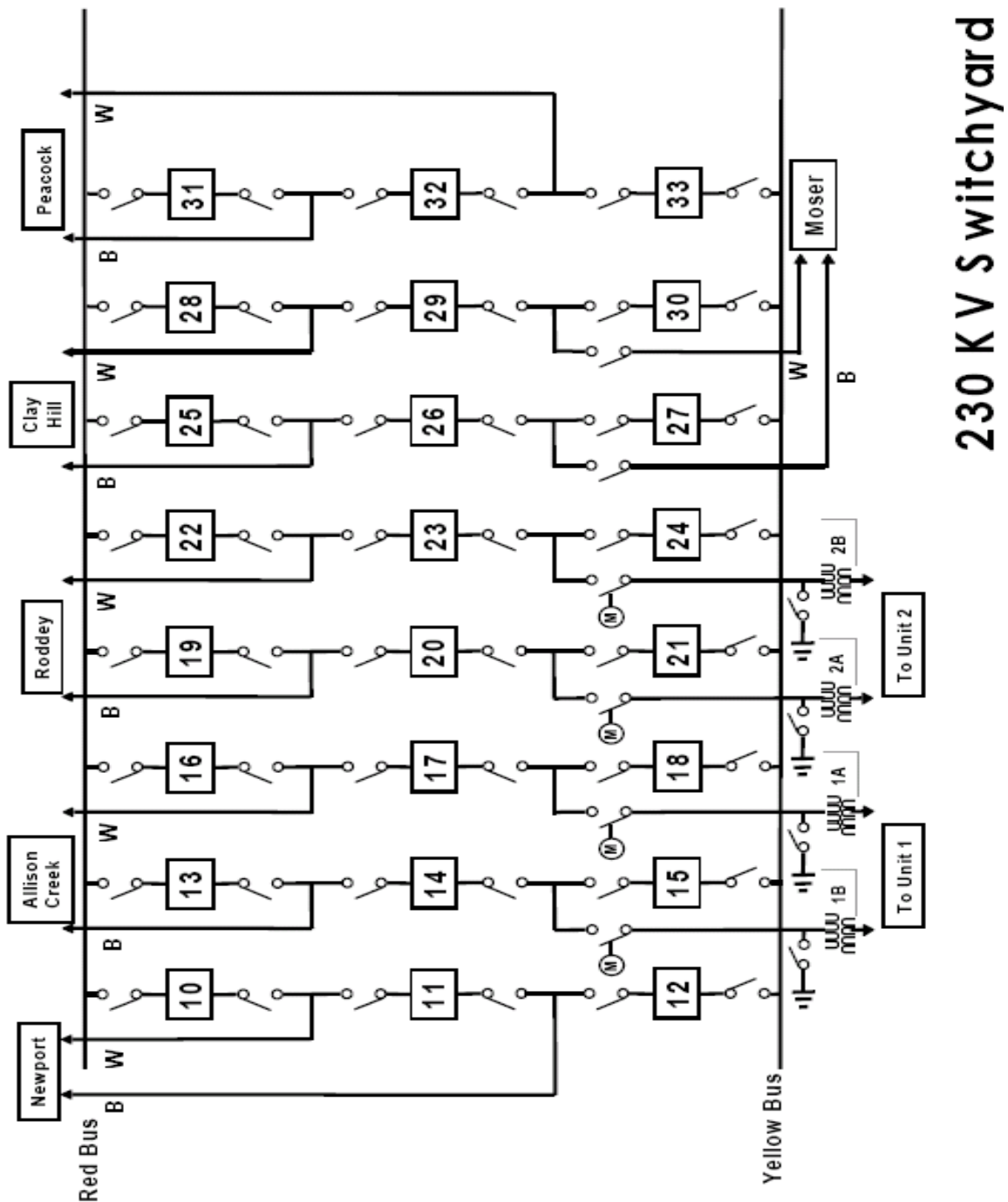
This Augmented Inspection is chartered to identify the circumstances surrounding this event and review the licensee's actions following discovery of the conditions.

Objectives of the AIT - The objectives of the inspection are to: (1) review the facts surrounding the LOSP on May 20, 2006, and related plant complications; (2) assess the licensee's response and investigation of the event; (3) identify any generic issues associated with the event; and (4) conduct an independent extent of condition review.

To accomplish these objectives, the following will be performed:

- a. Develop a complete sequence of events, including applicable management decision points, from the time the LOOP occurred until both units were stabilized.
- b. Identify and evaluate the effectiveness of the immediate actions taken by the licensee in response to this event including the accuracy and timeliness of the licensee's classification of the event.
- c. Identify additional actions planned by the licensee in response to this event, including the time line for their completion of the investigation and follow-on analysis.
- d. Assess the circumstances surrounding the multiple lifting and reseating of the Unit 1 and Unit 2 primary power operated relief valves.
- e. Determine if there are any generic issues related to this event which warrant an additional NRC response. As part of this review, assess the implications of a common cause failure of the emergency diesel generators due to external flooding. Promptly communicate any potential generic issues to regional management.
- f. Document the inspection findings and conclusions in an inspection report within 30 days of the inspection.

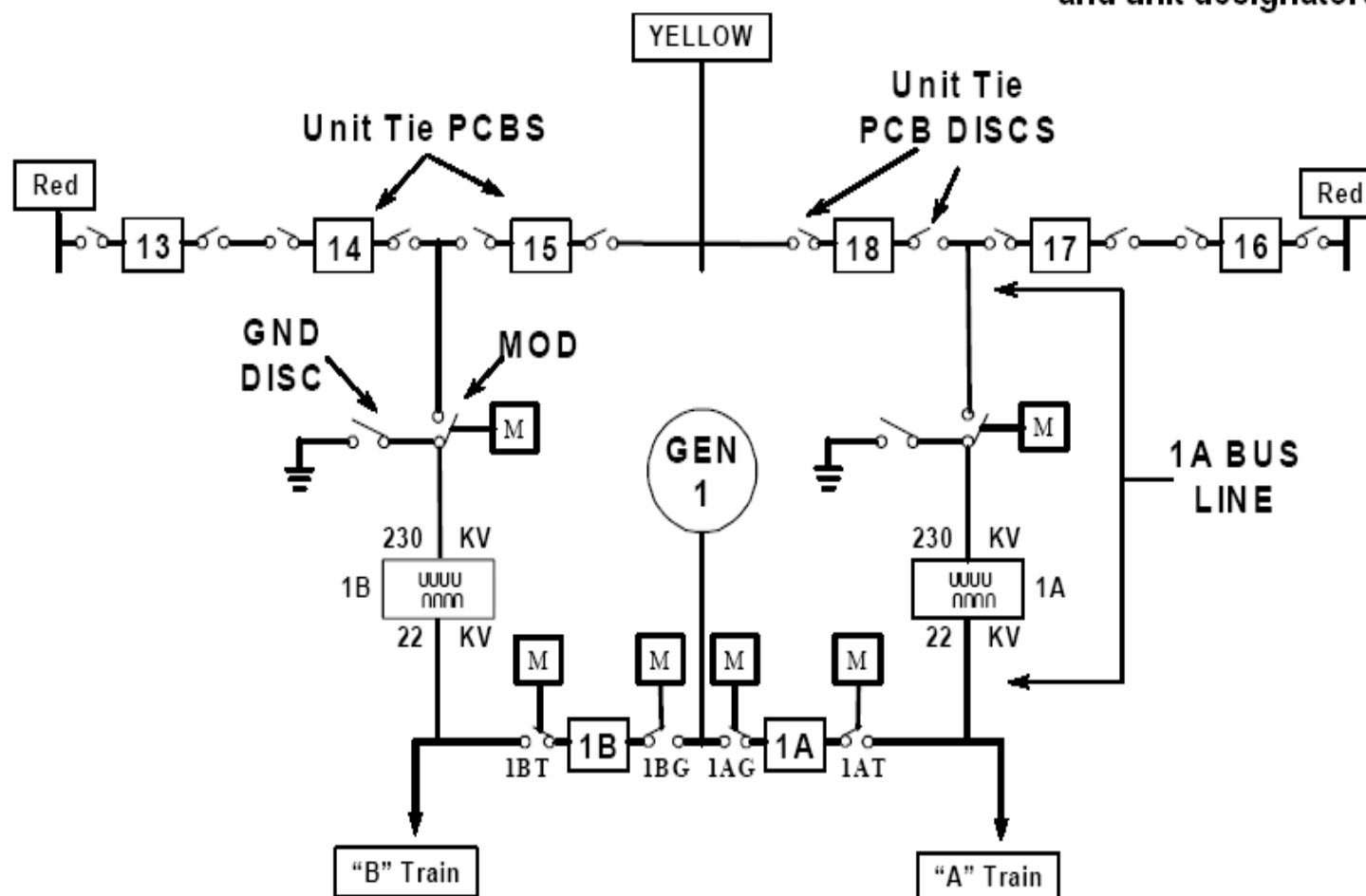
# CATAWBA HIGH VOLTAGE SWITCHYARD SIMPLIFIED DIAGRAM

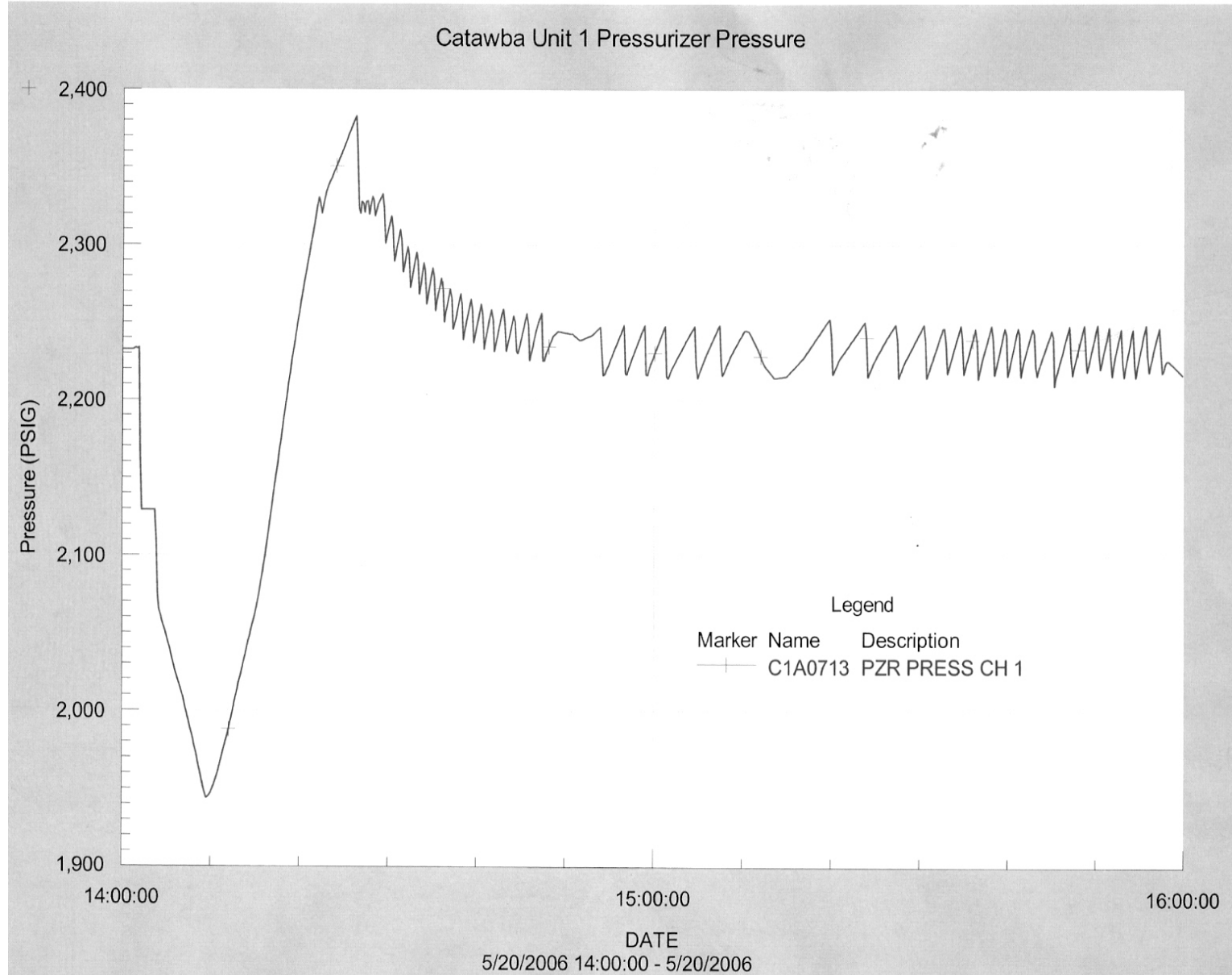


With both units at 100% power, all of the breakers shown in the simplified diagram above are in the CLOSED position.

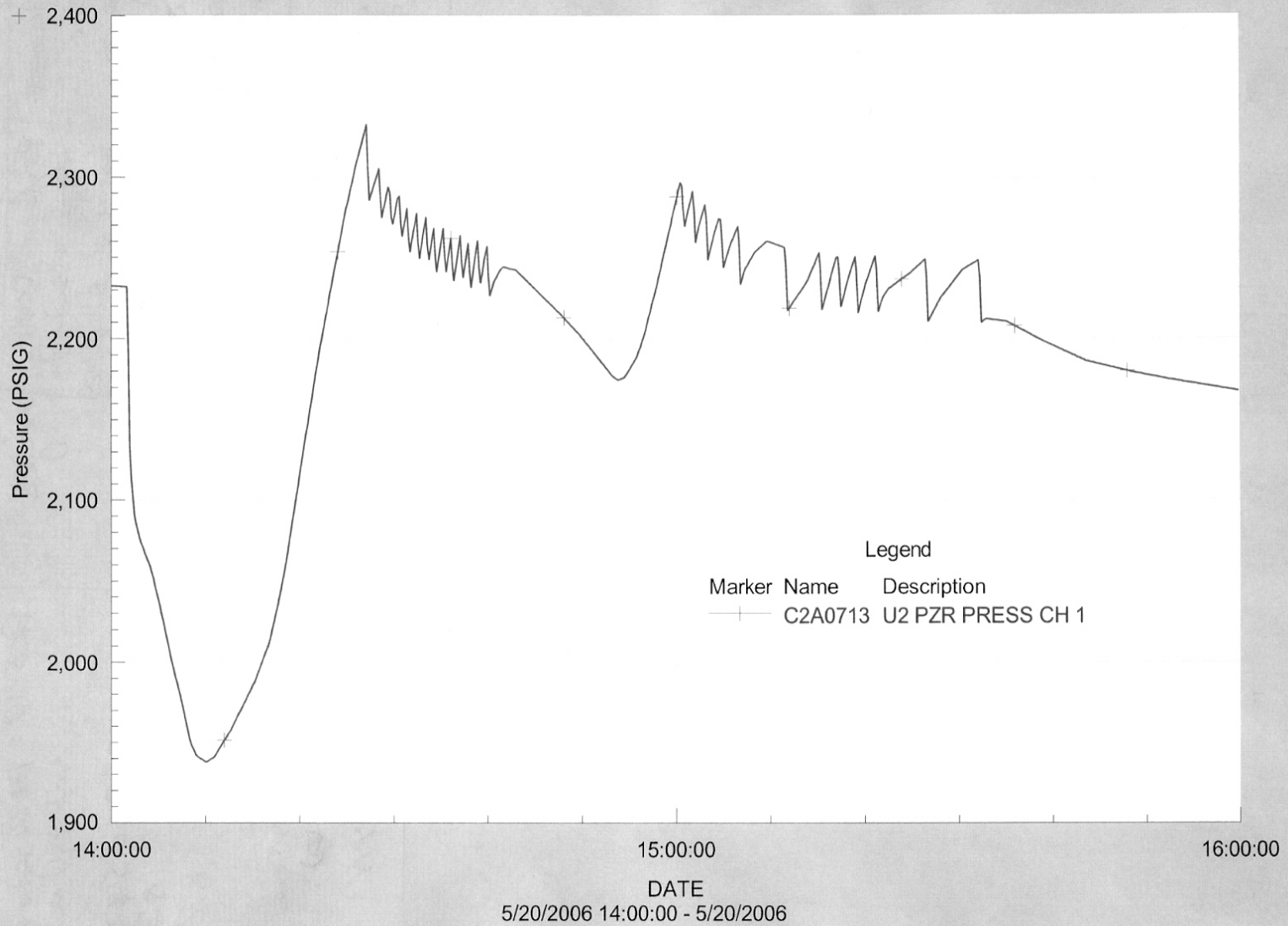
## 230/22 KV System

Unit 1 shown; Unit 2 is identical except for PCB #'s and unit designators





# Catawba Unit 2 Pressurizer Pressure



## ELECTRICAL PLANT SEQUENCE OF EVENTS

Unit	Time	Seconds from Event Initiation	Event
1	14:01:45.448	0.000	Fault occurs on the X-phase Current Transformer (CT) of Power Circuit Breaker (PCB) 18
1	14:01:45.465	0.017	Unit 1 Zone A protective lockout actuates (due to transformer 1A differential) to trip PCB's 17 and 18 and Generator Circuit Breaker (GCB) 1A
			Differential protective relaying actuates to clear the Red and Yellow busses (PCB 12 operation in response cannot be confirmed)
2	14:01:45.491	0.043	Unit 2 Zone B protective lockout actuates (due to transformer 2B differential) to trip PCB's 23, 24 and GCB 2B
2	14:01:46.068	0.620	Line distance relaying on the Roddey transmission line actuates to trip the remote line breaker and PCB 20, serving to isolate Unit 2 from all offsite power
2	14:01:45.510	1.062	Unit 2 reactor trip occurs due to underfrequency conditions on the reactor coolant pump electrical busses. The reactor protection system (RPS) generates a P4 protection signal which trips the main turbine
2	14:01:46.553	1.105	Unit 2 GCB 2B is tripped by the sequential protective tripping logic. Vital 4.16kV bus 2ETB loses power and activates the blackout logic which sends a start signal to the 2B diesel generator
1	14:01:48.172	2.724	Overcurrent conditions at the Newport Tie Station actuate a remote breaker trip, serving to isolate Unit 1 from all offsite power
1	14:01:49.394	3.946	Unit 1 reactor trip occurs due to receipt of a "NI Hi Flux Rate - Power Range" signal. The cause of this signal has been attributed to an electrical perturbation on the instrument bus resulting from the large fault in the switchyard and not from an actual change in reactor power significant enough to have produced a valid flux rate trip signal.

## ELECTRICAL PLANT SEQUENCE OF EVENTS (continued)

Unit	Time	Seconds from Event Initiation	Event
1 / 2	14:01:49.581	4.133	The RPS generates a P4 protection signal which trips the main turbine. Vital 4.16kV busses 1ETA, 1ETB and 2ETA lose power and the blackout logic is activated which sends a start signal to the respective diesel generators
2	14:01:55.610	10.162	The 2B diesel generator receives a start signal and begins to come up to speed in preparation for re-energizing the vital busses
1	14:02:04.094	18.646	Bus underfrequency conditions result in relay actuation to trip PCB 14
1	14:02:04.610	19.162	Unit 1 GCB 1A is tripped by the sequential protective tripping logic
1	14:02:04.610	19.162	The 1A and 1B diesel generators receive start signals and begin to come up to speed in preparation for re-energizing the vital busses
2	14:02:13.820	28.372	The 2A diesel generator receives a start signal and begins to come up to speed in preparation for re-energizing the vital busses
1 / 2			The load sequencers on all four (4) diesel generators initiate per design to energize the necessary blackout loads in the prescribed sequence ensuring the diesel generators are not overloaded. Under the blackout loading, Load Groups 1, 2, 3, 6, 7, 8, 9, 10, 11 and 12 are automatically re-energized by the diesel generators. Equipment in Load Group 13 is given a manual start permissive 11 minutes and 50 seconds following sequencer initiation.
1 / 2			All blackout loads are successfully re-energized via the diesel generators.



## EMERGENCY RESPONSE ORGANIZATION SEQUENCE OF EVENTS

The following table provides a summary of the actions taken by the Catawba Emergency Response Organization following the LOOP event of May 20, 2006.

**May 20, 2006**

TIME	COMMENT	DESCRIPTION
1401	Event Starts	Fault in the 230kV switchyard results in the loss of offsite power to both Catawba units and dual reactor trips from 100% power. All four emergency diesel generators start and re-energize the 4.16kV vital busses as designed.
1413	Emergency Response Organization (ERO) Pager message	Pagers set off to alert ERO to activate TSC and OSC for LOOP event
1414		Notice of Unusual Event is declared based on the loss of all AC power from offsite sources for more than 15 minutes with onsite power available. (Sent from the Control Room)
1421		Group call made to notify 4 of 5 state/local emergency management agencies. York County not available on selective signal call group.
1430	-----	Site Assembly initiated
1458		York County notified by commercial telephone line
1532	-----	Site Assembly completed, all personnel accounted for
1535	Message #2	Event update provided to 4 of 5 state/local emergency management agencies by selective signal call group. York County notified by commercial telephone line.
1550	-----	Technical Support Center (TSC) and Operations Support Center (OSC) activated
1615	-----	The NRC Operations Center was notified of the event by TSC staff 61 minutes late. The one hour notification was not made as required by the Control Room Offsite Agency Communicator.
1626	Message #3	Event update provided to State and local agencies (Sent from the TSC)
1717	Message #4	Event update provided to State and local agencies (Sent from the TSC)

1810	Message #5	Event update provided to State and local agencies (Sent from the TSC)
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**May 20, 2006 (continued)**

TIME	COMMENT	DESCRIPTION
1819	-----	Emergency Operations Facility (EOF) activated at the request of the TSC Emergency Coordinator. The EOF provided support to the site by assuming the responsibility of conducting offsite agency communications and performing dose projections.
1858	Message #6	Event update provided to State and local agencies (Sent from the EOF)
1949	Message #7	Event update provided to State and local agencies (Sent from the EOF)
2041	Message #8	Event update provided to State and local agencies (Sent from the EOF). Offsite power restoration in progress. Message content " <i>Offsite power partially restored to Unit 2 at 2027</i> "
2054	Message #9	Event update provided to State and local agencies (Sent from the EOF). Message content " <i>Offsite power restoration in progress. Offsite power partially restored to both Unit 1 and Unit 2.</i> "
2148	Message #10	Event update provided to State and local agencies (Sent from the EOF). Message content " <i>Power restoration to plant systems in progress.</i> "
2246	Message #11	Event update provided to State and local agencies (Sent from the EOF). Message content " <i>Power and equipment restoration continues. Commencing cooldown to comply with facility Technical Specifications.</i> "
2339	Message #12	Event update provided to State and local agencies (Sent from the EOF). Message content " <i>Power and equipment restoration continues. Cooldown on both units in progress to comply with facility Technical Specifications.</i> "

**May 21, 2006**

TIME	COMMENT	DESCRIPTION
0033	Message #13	Event update provided to State and local agencies (Sent from the EOF). Message content " <i>Equipment and power restoration continues. Power has been restored to 3 of 4 essential busses. Cooldown continues on both units to comply with facility Technical Specifications.</i> "
0123	Message #14	Event update provided to State and local agencies (Sent from the EOF). Message content " <i>Cooldown no longer necessary and temperatures are being maintained steady. Power has now been restored to all 4 essential busses from offsite sources.</i> "
0145	Message #15	Event update provided to State and local agencies (Sent from the EOF). Message content " <i>Power has been restored to all essential busses. Plant conditions are stable. Unusual Event has been terminated.</i> "

## INTEGRATED PLANT SEQUENCE OF EVENTS

### Catawba Unit 1

TIME	EVENT DESCRIPTION
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**May 20, 2006**

14:01:45	An internal fault occurred in a current transformer associated with power circuit breaker (PCB) 18. This fault resulted in a loss of the 230 kV Yellow and Red busses and a 1A Zone lockout.
14:01:49	The first-out annunciator was "NI Hi Flux Rate – Power Range"; however, a review of reactor power traces do not show any valid increase or change in reactor power at this time (NOTE: The licensee is reviewing data to determine the cause of this signal). Both reactor trip breakers open and control rods insert. The main turbine trips on receipt of the reactor trip signal.
14:02:13	Diesel generators 1A and 1B start and re-energize the 1ETA and 1ETB 4.16kV emergency busses as designed.
14:02:30	Both main feedwater pumps trip on Lo-Lo suction pressure as a result of the loss of the hotwell and condensate booster pumps. The auxiliary feedwater pumps (two motor-driven and one turbine-driven) start automatically and provide inventory makeup to the steam generators.
14:07:34	Letdown isolation occurs when pressurizer level reaches 17%. Excess letdown could not be established due to the failure of the excess letdown control valve to open on demand. Normal letdown was subsequently re-established through the fixed orifice line due to the variable orifice control valve failing closed following the LOOP and not re-opening.
14:08:02	Main Steam Isolation signal is received when the 1C steam generator pressure reached 775 psig on 2/3 channels. Secondary pressure control transitions to the steam generator PORV's.
14:12	Intermediate Range nuclear instrumentation drops below 1E-10 amps (P6 setpoint).
14:14	Operations Shift Manager declared a Notice of Unusual Event (Emergency Action Level 4.5.U.1, "AC electrical power from all offsite sources has been lost for more than 15 minutes with onsite power available") due to the dual unit loss of offsite power. Emergency Response Organization page sent to activate the Technical Support Center (TSC) and Operations Support Center (OSC) (See Emergency Event Notification timeline for details on the licensee's response to the event).

- 14:22 Due to the loss of pressurizer spray (no forced circulation following the loss of the reactor coolant pumps), two of three pressurizer PORV's begin to cycle to control primary system pressure. (See section 4OA5.4 for details on the pressurizer PORV lifts). No pressurizer safety valves opened during the event.
- 14:55 Normal letdown is restored through the fixed orifice line.
- 20:34 Unit is stabilized on natural circulation using emergency, abnormal and normal operating procedures. Primary system parameters are being controlled through the use of auxiliary feedwater and steam generator PORV's.
- 20:40 Offsite power is restored to the 6.9kV non-vital busses. Work is in-progress to energize the 4.16kV vital busses from offsite power and secure the diesel generators.
- 21:55 Final pressurizer PORV actuation. Total number of actuations during event on PORV 1NC-34A was 57 cycles and on PORV 1NC-32B, five cycles.
- 23:03 4.16kV vital bus 1ETB is aligned to offsite power.
- 23:06 1B diesel generator output breaker is opened. Actions initiated to secure the 1B diesel generator and place it in stand-by.

### **May 21, 2006**

- 01:11 4.16kV vital bus 1ETA is aligned to offsite power. Due to the 1A Zone lockout, power is being supplied from the Unit 2 A SAT using procedural guidance to establish the required alignment.
- 01:14 1A diesel generator output breaker is opened. Actions initiated to secure the 1A diesel generator and place it in stand-by.
- 01:40 Notice of Unusual Event is terminated following restoration of offsite power to all unit busses.
- 15:17 The 1B reactor coolant pump is placed in service restoring forced circulation in the primary system and providing normal pressurizer sprays for pressure control if required. Primary system is stabilized at 475 F and 1850 psig in Mode 3.

**May 22, 2006**

- 06:03 The 1B reactor coolant pump motor stator winding temperatures increase to 295°F requiring the pump to be secured. The 1A reactor coolant pump is started.
- 08:35 Stator winding temperatures on the 1A reactor coolant pump motor increase and approach the 300°F operating limit. The pump is secured and the decision made to cool down to Mode 5 using natural circulation in order to place residual heat removal in service. (NOTE: The elevated temperatures were determined to have been caused by biological debris being swept into the motor coolers when the source of cooling water swapped from the normal containment chilled water system to the backup nuclear service water system on the loss of offsite power).
- 08:49 Briefing conducted to initiate a natural circulation Cooldown to Mode 5.
- 16:07 Unit 1 enters Mode 4

**May 23, 2006**

- 09:09 Unit 1 enters Mode 5
- The unit is stabilized at 170°F and 295 psig in Mode 5. The A train of residual heat removal is placed in-service for decay heat removal. The B train is placed in-service at 21:17. Repair and recovery actions are initiated.

## CATAWBA UNIT 2

TIME	EVENT DESCRIPTION
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May 20, 2006

14:01:45	An internal fault occurred in a current transformer associated with power circuit breaker (PCB) 18. This fault resulted in a loss of the 230 kV Yellow and Red busses and a 2B Zone lockout.
14:01:46	The first-out annunciator is "Under Frequency Conditions on the Reactor Coolant Pump Busses" as sensed by the reactor coolant pump monitoring circuit. Both reactor trip breakers open and control rods insert. The main turbine trips on receipt of the reactor trip signal.
14:02	Diesel generators 2A and 2B start and re-energize the 2ETA and 2ETB 4.16kV emergency busses as designed.
14:02	Both main feedwater pumps trip on Lo-Lo suction pressure as a result of the loss of the hotwell and condensate booster pumps. The auxiliary feedwater pumps (two motor-driven and one turbine-driven) start automatically and provide inventory makeup to the steam generators.
14:08:05	Letdown isolation occurs when pressurizer level reaches 17%. Excess letdown is placed in service. Normal letdown was subsequently re-established.
14:08:21	Main Steam Isolation signal is received when the 2A steam generator pressure reached 775 psig on 2/3 channels. Secondary pressure control transitioned to the steam generator PORV's.
14:27	Due to the loss of pressurizer spray (no forced circulation following the loss of the reactor coolant pumps), one of three pressurizer PORV's begins to cycle to control primary system pressure. (See section 4OA5.4 for details on the pressurizer PORV lifts). No pressurizer safety valves opened during the event.
14:13	Intermediate Range nuclear instrumentation drops below 1E-10 amps (P6 setpoint).
14:14	Operations Shift Manager declares a Notice of Unusual Event (Emergency Action Level 4.5.U.1, "AC electrical power from all offsite sources has been lost for more than 15 minutes with onsite power available") due to the dual unit loss of offsite power. Emergency Response Organization page is sent to activate the Technical Support Center (TSC) and Operations Support Center (OSC). (See Emergency Event Notification timeline for details on the licensee's response to the event)
18:10	Final pressurizer PORV actuation. Total number of actuations during event on PORV 2NC-34A was 35 cycles.

----- Unit is stabilized on natural circulation using emergency, abnormal and normal operating procedures. Primary system parameters are being controlled through the use of auxiliary feedwater and steam generator PORV's.

20:27 Offsite power is restored to the 6.9kV non-vital busses. Work is in-progress to re-energize the 4.16kV vital busses from offsite power and secure the diesel generators.

23:31 4.16kV vital bus 2ETA is aligned to offsite power.

23:36 2A diesel generator output breaker is opened. Actions initiated to secure the 2A diesel generator and place it in stand-by.

23:53 4.16kV vital bus 2ETB is aligned to offsite power. Due to the 2B Zone lockout, power is being supplied from the Unit 1 B SAT using procedural

#### **May 21, 2006**

23:57 2B diesel generator output breaker is opened. Actions initiated to secure the 2B diesel generator and place it in stand-by.

01:40 Notice of Unusual Event terminated following restoration of offsite power to all unit busses.

11:06 The 2B reactor coolant pump was placed in service restoring forced circulation in the primary system and providing normal pressurizer sprays for pressure control if required. Exited Natural Circulation EP and transitioned to OP/2/A/6100/002; Controlling Procedure for Unit Shutdown

12:00 The unit was stabilized at 460 F and 1900 psig in Mode 3. Recovery actions are initiated.

#### **May 22, 2006**

11:00 Vacuum is reestablished in the main condenser allowing secondary pressure control to be transferred from the steam generator PORV's to the steam dumps and conserve inventory required to feed the steam generators.